REMARKS

Claims Amendments. Claim 26 now recites that a main constituent of the adhesion layer is different from a main constituent of the semiconductor thin film; this is supported by the specification's disclosure that the main constituent of the adhesion layer 104 "mainly consists of semiconductor material" (page 5, line 14) such as silicon (page 7, line 1 of last paragraph), while the semiconductor thin films 106 (see page 5, line 18) is made of GaAs layer or $Al_xGa_{1-x}As$ (page 16, line 15) while the layer 105 is "electrically conductive" (page 8, line 3) and layer 11 is of GaAs (bottom of page 8).

Claim 26 also recites that the semiconductor material has an affinity to both of the semiconductor thin film and substrate, which is supported at the fifth line from bottom of page 7, and page 8, line 7; page 15, first full paragraph; and page 20, last full paragraph.

Claim 39 recites a monolithic Si substrate with an integrated circuit (page 7, lines 1-4).

[1-2] The specification is amended as suggested. Withdrawal of the objection is requested.

[3] The claims are amended as suggested. The re-numbered claims 21 and up are canceled and the objection is moot. Withdrawal of the objection is requested.

[4-5] Claims 15 and 21 were rejected under §112, second paragraph. Claim 21 is canceled. Claim 34, which corresponds to renumbered/canceled claim 21, is amended so that "first" is deleted. Claim 15 is amended to depend from claim 3, which recites the first interdielectric layer. Withdrawal of the rejection is requested.

(Claim 26) New independent claim 26 includes the features of canceled claim 1. Claim 26 recites the following features:

(a) a substrate;

(b) at least one semiconductor thin film including at least one semiconductor device; and

(c) an adhesion layer disposed on said substrate, said adhesion layer mainly consisting of semiconductor material, a main constituent of said adhesion layer being different from a main constituent of said at least one semiconductor thin film, said semiconductor material having an affinity to both of said at least one semiconductor thin film and said substrate;

(d) said at least one semiconductor thin film being bonded on said adhesion layer.

(1) Because of the above-mentioned features, a high bonding strength can be established between the substrate and the semiconductor thin film, which were separately formed and made of different kinds of material. The semiconductor thin film that is bonded to the substrate is made in advance from another substrate, which is especially suitable for forming the semiconductor thin film and is different from the recited substrate. Therefore, a semiconductor apparatus which has few lattice defects is obtained.

(2) In contrast to claim 26, the reference Noguchi discloses that the semiconductor thin film is made of polysilicon and the adhesion layer is made of silicon, silicide, cermet, or silicon carbide. Silicon and silicide include silicon as a main constituent, which is the same as a main constituent of the polysilicon forming the semiconductor thin film. Also, cermet and silicon carbide are not semiconductor materials. Therefore, Noguchi does not disclose the materials of the semiconductor thin film and the adhesion layer of the Applicant's claims, and also does not disclose the combination of materials recited in the instant claims.

In addition, the semiconductor thin film of Noguchi is formed on the adhesion layer by liquid phase growth, and therefore does not have the effect of the presently-claimed invention; namely, the effect of establishing a high bonding strength between the substrate and the

semiconductor thin film, which were separately formed and are made of different kinds of material.

(Claim 31) The Applicant believes that the features of the present invention are made especially clear in claim 31, reciting:

(a) the substrate and the semiconductor thin film have main constituents different from each other;

(b) the semiconductor thin film is a compound semiconductor; and

(c) the adhesion layer is polysilicon or amorphous silicon.

A precondition of the this subject matter is as follows.

First, it is preferable to form a compound semiconductor layer with good semiconductor characteristics on a low-cost substrate with a wide surface area.

Second, the semiconductor thin film can be formed directly on the substrate by a gas phase growth or a liquid phase growth.

However, if the substrate does not have a desired lattice structure, the desired semiconductor characteristics can hardly be obtained. A large number of defects may be generated.

To resolve these problems, the present invention utilizes a technique of bonding one semiconductor thin film, that was formed separately and has a desired characteristics, onto the substrate. If a main constituent of the semiconductor thin film is different from a main constituent of the substrate, bonding strength between the semiconductor thin film and the substrate is low. However, it is difficult to form an adhesion layer having the same main constituent as the compound semiconductor thin film. Therefore, the Applicant uses a material such as a polysilicon layer, or an amorphous silicon layer, as an adhesion layer.

A polysilicon layer or amorphous silicon layer can easily be formed on the substrate. This seems to be because the polysilicon layer or amorphous silicon layer does not have a single

crystalline structure. In addition, a polysilicon layer or amorphous silicon layer has an affinity to the semiconductor thin film made of a compound semiconductor, so high bonding strength can be obtained.

(1) In contrast to the present invention, the method disclosed in the reference Noguchi relates to forming a solar battery of polysilicon on the substrate by phase growth, and therefore a main constituent of the semiconductor thin film of Noguchi is different from that of the claimed invention.

(2) The non-applied reference, Sugawara, discloses feature (a) above, that is, the feature that the substrate and the semiconductor thin film have main constituents different from each other. However, Sugawara differs from the present invention in feature (c), that is, the adhesion layer which is polysilicon or amorphous silicon. Sugawara discloses a method of forming a compound semiconductor as an adhesion layer on a sapphire substrate, but this method requires an extreme techniques and can hardly be expected to produce a compound semiconductor with the desired characteristics. Therefore, in an element including a compound semiconductor made by the method of Sugawara, the yield is low, improved performance is difficult to achieve, and in the worst cases the element is unusable.

In contrast, the Applicant's adhesion layer, such as a polysilicon layer or an amorphous silicon layer, is easy to form on the substrate; and the semiconductor thin film, which was separately formed and has good semiconductor characteristics, is bonded to the adhesion layer. Therefore, it is easy to form a semiconductor apparatus with good characteristics on a low-cost substrate, while establishing a high bonding strength between the substrate and the semiconductor thin film.

As described above, only when the apparatus includes all the features (a) to (c) can the effect of the present invention—a low-cost semiconductor apparatus with good characteristics—be obtained.

[8] Claims 1-2, 5-9, and 16-17 were rejected under §102(b) as being anticipated by Sugawara '197. This rejection is respectfully traversed.

(1) New claim 26 was argued for above.

(2) In Sugawara, the semiconductor thin films 102 and 103 are made of a compound material such as InAlP, and the adhesion layer (paragraph 0063) is also made of InAlP.

The Examiner regards the sapphire substrate as ceramic. With respect, sapphire is not a ceramic material but a crystal material. Furthermore, although Sugawara discloses that the above-described adhesion layer is a cladding layer 103, it appears to the Applicant that the above-described adhesion layer functions as a buffer layer, which acts as a bridge of crystalline lattices between the sapphire (crystal) substrate 104 and the light emitting layer 102 formed on the sapphire (crystal) substrate 104 by gas phase growth.

In other words: in Sugawara, since the main constituent of the adhesion layer is the same as that of the semiconductor thin film, the affinity between the adhesion layer and the substrate is the same as the affinity between the semiconductor thin film and the substrate. Therefore, the bonding strength between the adhesion layer and the substrate is the same as the bonding strength between the semiconductor thin film and the substrate.

It appears to the Applicant that the adhesion layer Sugawara is not a layer that can increase the bonding strength, but instead is a layer that bridges the lattice constants, namely, a layer that satisfies a preferred condition in the lattice constants required for bonding (strictly speaking, crystal growing) the semiconductor thin film to the substrate via the adhesion layer.

[9-10] Claims 20-24 were rejected under §103(a) as being unpatentable over Sugawara in view of Fukusawa '861. This rejection is respectfully traversed.

New claims 34-38 (corresponding generally to canceled claims 20-24) all depend from new claim 26, which is argued above to be allowable. Claims 34-38 are allowable for, *inter alia*, that reason.

New Claim 39. Claims 39 recites a substrate which is a monolithic Si substrate including an integrated circuit, together with the other features. These features are not disclosed in the prior art.

As is noted above, claims 3, 4, 10-14, 15, 18, and 19 are amended to be allowable.

Respectfully submitted,

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